– Solutions –

Additional Midterm Review Questions

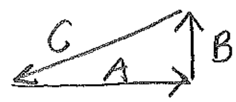
Scalars and Vectors
Vector Addition and Subtraction

C 1. Which one of the following quantities is a vector quantity?
(a) the age of the earth
(b) the mass of a freight train
(c) the earth's pull on your body
(d) the temperature of hot cup of coffee
(e) the number of people attending a soccer game

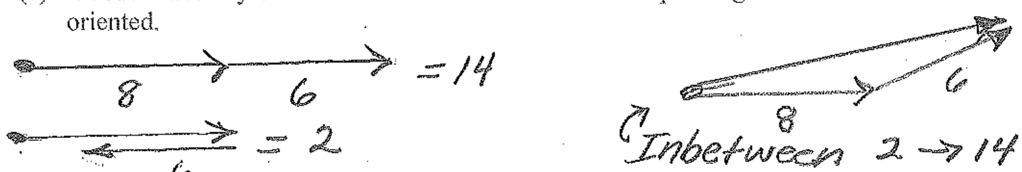
A, B, D and E are just #'s No direction
C.) Earths pull = Force due to gravity has both mag. & dir.

B 2. What is the minimum number of vectors with *unequal* magnitudes whose vector sum can be zero?
(a) two
(b) three
(c) four
(d) five
(e) six

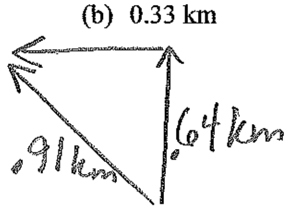
Unequal Magnitudes means 2 vectors can't add up to zero, but $\vec{A}+\vec{B}+\vec{C}$ can = 0 →



E 3. A physics student adds two displacement vectors with magnitudes of 8.0 km and 6.0 km. Which one of the following statements is true concerning the magnitude of the resultant displacement?
(a) It must be 10.0 km.
(b) It must be 14.0 km.
(c) It could be equal to zero kilometers, depending on how the vectors are oriented.
(d) No conclusion can be reached without knowing the directions of the vectors.
(e) It could have any value between 2.0 km and 14.0 km depending on how the vectors are oriented.



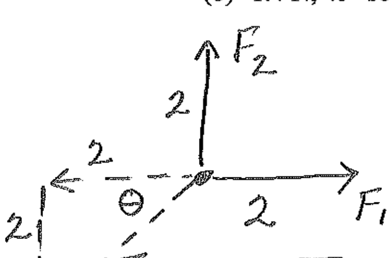
E 4. A runaway dog walks 0.64 km due north. He then runs due west to a hot dog stand. If the magnitude of the dog's total displacement vector is 0.91 km, what is the magnitude of the dog's displacement vector in the due west direction?
(a) 0.27 km
(b) 0.33 km
(c) 0.41 km
(d) 0.52 km
(e) 0.65 km



$.64^2 + x^2 = .91^2$

$x^2 = .4185 \quad x = .65\text{m}$

D 5. A force, $\mathbf{F}_1$, of magnitude 2.0 N and directed due east is exerted on an object. A second force exerted on the object is $\mathbf{F}_2 = 2.0$ N, due north. What is the magnitude and direction of a third force, $\mathbf{F}_3$, which must be exerted on the object so that the resultant force is zero?
(a) 1.4 N, 45° north of east
(b) 1.4 N, 45° south of west
(c) 2.8 N, 45° north of east
(d) 2.8 N, 45° south of west
(e) 4.0 N, 45° east of north



$\theta = \tan^{-1}\left(\frac{2}{2}\right) = 45°$ South of West

$F_3 = \sqrt{2^2+2^2} = \sqrt{8} = 2.8\text{ N}$

The Components of a Vector

A 6. A displacement vector has a magnitude of 810 m and points at an angle of 18° above the positive x axis. What are the x and y scalar components of this vector?

	x scalar component	*y scalar component*
(a)	770 m	250 m
(b)	560 m	585 m
(c)	585 m	560 m
(d)	250 m	750 m
(e)	713 m	385 m

$y = 810 \sin 18° = 250 m$

$x = 810 \cos 18° = 770 m$

A 7. A racecar will make one lap around a circular track of radius R. When the car has traveled *halfway* around the track, what is the magnitude of the car's displacement from the starting point?

(a) $2R$ (b) R (c) πR (d) $2\pi R$ (e) zero meters

$\Delta X = X_f - X_i$

8. A vector $\mathbf{F}_1$ has a magnitude of 40.0 units and points 35.0° above the positive x axis. A second vector $\mathbf{F}_2$ has a magnitude of 65.0 units and points in the negative y direction. Use the component method of vector addition to find the magnitude and direction, relative to the positive x axis, of the resultant $\mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2$.

(a) 53.3 units, 52.1° below the $+x$ axis
(b) 53.3 units, 52.1° above the $+x$ axis
(c) 76.3 units, 37.9° below the $+x$ axis
(d) 76.3 units, 52.1° above the $+x$ axis
(e) 9.23 units, 37.9° below the $+x$ axis

$40 \sin 35° = 23$, $40 \cos 35° = 32.8$

$F_1 = 32.8\hat{x} + 23\hat{y}$

$F_2 = 0\hat{x} - 65\hat{y}$

$F_3 = 32.8\hat{x} - 42\hat{y}$

Displacement, Speed and Velocity

C 9. A particle travels along a curved path between two points P and Q as shown. The displacement of the particle does *not* depend on

(a) the location of P.
(b) the location of Q.
(c) the distance traveled from P to Q.
(d) the shortest distance between P and Q.
(e) the direction of Q from P.

$\Delta X = X_f - X_i$

ΔX depends on end points only

E 10. A Canadian goose flew 845 km from Southern California to Oregon with an average speed of 30.5 m/s. How long, in hours, did it take the goose to make this journey?

(a) 27.7 h (b) 8.33 h (c) 66.1 h (d) 462 h (e) 7.70 h

$v = \frac{d}{t}$ $t = \frac{d}{v} = \frac{845000\,m}{30.5\,m/s} = 27,704\,sec \cdot \frac{1\,hr}{3600\,sec} = 7.7\,hr$

A 11. Carl Lewis set a world record for the 100.0-m run with a time of 9.86 s. If, after reaching the finish line, Mr. Lewis walked directly back to his starting point in 90.9 s, what is the magnitude of his average velocity for the 200.0 m?

(a) 0 m/s (b) 1.10 m/s (c) 1.98 m/s (d) 5.60 m/s (e) 10.1 m/s

$\text{Ave. Velocity} = \frac{\Delta X}{\Delta t} = \frac{X_f - X_i}{\Delta t} = 0$

Acceleration

B 12. An elevator is moving upward with a speed of 11 m/s. Three seconds later, the elevator is still moving upward, but its speed has been reduced to 5.0 m/s. What is the average acceleration of the elevator during the 3.0 s interval?

(a) 2.0 m/s², upward (c) 5.3 m/s², upward (e) 2.7 m/s², downward
(b) 2.0 m/s², downward (d) 5.3 m/s², downward

$v_i = +11$ m/s $v_f = +5$ m/s

$v_f = v_i + at$ $-6 = a(3)$ ← neg means downward
$5 = 11 + a(3)$ $a = -2$ m/s²

D 13. Which one of the following statements must be true if the expression $x = v_0t + \frac{1}{2}at^2$ is to be used?

(a) x is constant. (c) t is constant. (e) Both v_0 and t are constant.
(b) v is constant. (d) a is constant.

$x_f = x_i + v_i t + \frac{1}{2}at^2$ ← Const Accel. Equation

B 14. The minimum takeoff speed for a certain airplane is 75 m/s. What minimum acceleration is required if the plane must leave a runway of length 950 m? Assume the plane starts from rest at one end of the runway.

(a) 1.5 m/s² (c) 4.5 m/s² (e) 7.5 m/s²
(b) 3.0 m/s² (d) 6.0 m/s²

$v_i = 0$ $x_i = 0$ $x_f = 950$ m

$v_f^2 = v_i^2 + 2a\Delta x$

$75^2 = 2(a)950$ → $a = \frac{75^2}{1900} = 2.96$ m/s²

Freely Falling Bodies

C 15. A ball is dropped from rest from a tower and strikes the ground 125 m below. Approximately how many seconds does it take the ball to strike the ground after being dropped? Neglect air resistance.

(a) 2.50 s (c) 5.05 s (e) 16.0 s
(b) 3.50 s (d) 12.5 s

$y_f = y_i + v_i t + \frac{1}{2}at^2$ ($v_i = 0$)

$0 = 125 + \frac{1}{2}(-9.8)t^2$

$t^2 = \frac{125}{4.9} = 25.5$ $t = 5.05$ sec

C 16. Elijah throws a tennis ball vertically upward. The ball returns to the point of release after 3.5 s. With what speed did he throw the ball?

(a) 0 m/s (c) 17 m/s (e) 34 m/s
(b) 14 m/s (d) 21 m/s

$y_f = y_i + v_i t + \frac{1}{2}at^2$

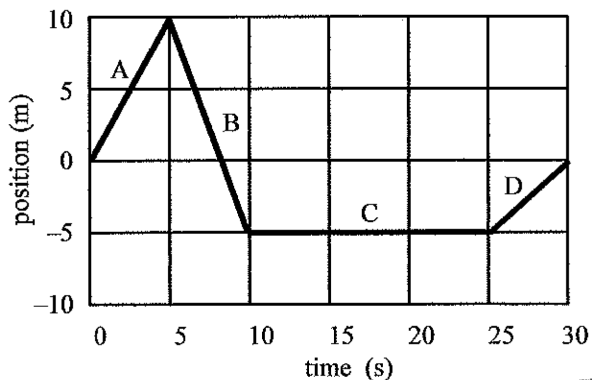
$0 = 0 + v_i(3.5) + \frac{1}{2}(-9.8)(3.5)^2$

$3.5 v_i = 60.025$

$v_i = 17.15$ m/s

Graphical Analysis

An object is moving along the x axis. The graph shows its position from the starting point as a function of time. Various segments of the graph are identified by the letters A, B, C, and D.



A

17. During which interval(s) is the object moving in the negative x direction?
    - (a) during interval B only
    - (b) during intervals B and C
    - (c) during intervals C and D
    - (d) during intervals B and D
    - (e) during intervals B, C, and D

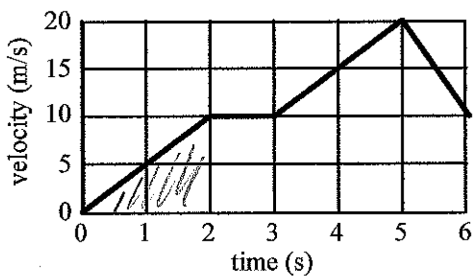
A = Moving Forward
B = Backward
C = Not moving
D = Forward but on neg side of x-axis

D

18. What is the *velocity* of the object at $t = 7.0$ s?
    - (a) +3.0 m/s
    - (b) −1.0 m/s
    - (c) −2.0 m/s
    - (d) −3.0 m/s
    - (e) zero m/s

$v = \frac{\Delta x}{\Delta t} = \text{Slope} = \frac{\text{Rise}}{\text{Run}} = \frac{-5-(10)}{5} = -3$

GRAPH BELOW IS FOR PROBLEMS 19, 20, 21, 22



B

19. During which interval(s) of the graph does the object travel *equal distances* in *equal times*?
    - (a) 0 s to 2 s
    - (b) 2 s to 3 s
    - (c) 3 s to 5 s
    - (d) 0 s to 2 s and 3 s to 5 s
    - (e) 0 s to 2 s, 3 to 5 s, and 5 to 6 s

0−2 sec = Accelerating
2−3 sec = Const Vel.
3−5 sec = Accel.
5−6 sec = Decel.

D

20. During which interval(s) of the graph does the speed of the object *increase by equal amounts* in *equal times*?
    - (a) 0 s to 2 s
    - (b) 2 s to 3 s
    - (c) 3 s to 5 s
    - (d) 0 s to 2 s and 3 s to 5 s
    - (e) 0 s to 2 s, 3 to 5 s, and 5 to 6 s

0−2 and 3−5 = const. accel.

B

21. How far does the object move in the interval from $t = 0$ to $t = 2$ s?
    - (a) 7.5 m
    - (b) 10 m
    - (c) 15 m
    - (d) 20 m
    - (e) 25 m

$v = \frac{\Delta x}{\Delta t}$ $\Delta x = v\Delta t$ = Area $= \frac{1}{2}(2)(10) = 10$ (height, Base)

E

22. What is the acceleration of the object in the interval from $t = 5$ s to $t = 6$ s?
    - (a) $-40\ m/s^2$
    - (b) $+40\ m/s^2$
    - (c) $-20\ m/s^2$
    - (d) $+20\ m/s^2$
    - (e) $-10\ m/s^2$

$a = \frac{\Delta v}{\Delta t} = \text{slope} = \frac{v_f - v_i}{\Delta t} = \frac{10-(20)}{1\,sec} = \frac{-10\ m/s}{1\,sec} = -10\ m/s^2$

The Concepts of Force and Mass - Newton's First Law - Newton's Second Law

E

23. Complete the following statement: The term *net force* most accurately describes
    - (a) the mass of an object
    - (b) the inertia of an object.
    - (c) the quantity that causes displacement.
    - (d) the quantity that keeps an object moving.
    - (e) the quantity that changes the velocity of an object.

$F = ma = m\frac{\Delta v}{\Delta t}$ →

E

24. Which one of the following terms is used to indicate the natural tendency of an object to remain at rest or in motion at a constant speed along a straight line?
    - (a) velocity
    - (b) force
    - (c) acceleration
    - (d) equilibrium
    - (e) inertia

Newton's 1st law

C

25. A net force **F** is required to give an object with mass *m* an acceleration **a**. If a net force 6 **F** is applied to an object with mass 2*m*, what is the acceleration on this object?
    - (a) **a**
    - (b) 2**a**
    - (c) 3a
    - (d) 4**a**
    - (e) 6**a**

$F = ma$

New $6F = 2m(a_{New}) \rightarrow a_{New} = \frac{3F}{m} = 3a$

D

26. A 15-N net force is applied for 6.0 s to a 12-kg box initially at rest. What is the speed of the box at the end of the 6.0-s interval?
    - (a) 1.8 m/s
    - (b) 15 m/s
    - (c) 3.0 m/s
    - (d) 7.5 m/s
    - (e) 30 m/s

$v_i = 0$

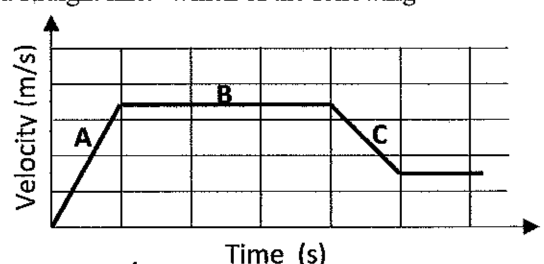
$F = ma$

$15 = 12(a)$ $a = \frac{5}{4}$

$v_f = v_i + at$

$v_f = \frac{5}{4}(6) = \frac{30}{4} = 7.5$ m/s

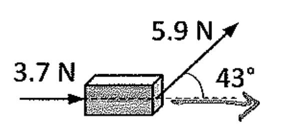
27. The figure shows the velocity versus time curve for a car traveling along a straight line. Which of the following statements is false?
    - (a) No net force acts on the car during interval **B.**
    - (b) Net forces act on the car during intervals **A** and **C**.
    - (c) Opposing forces may be acting on the car during interval **B**.
    - (d) Opposing forces may be acting on the car during interval **C**.
    - (e) The magnitude of the net force acting during interval **A** is less than that during **C**.



$F = ma$ $a = \frac{\Delta v}{\Delta t} = $ slope Slope A > Slope C ∴ $F_A > F_C$

The Vector Nature of Newton's Second Law and Newton's Third Law of Motion

28. Two forces act on a 4.5-kg block resting on a frictionless surface as shown. What is the magnitude of the horizontal acceleration of the block?
    - (a) 1.8 m/s^2
    - (b) 1.2 m/s^2
    - (c) 0.82 m/s^2
    - (d) 3.2 m/s^2
    - (e) 8.9 m/s^2



$5.9\cos 43° = 4.3$ N

$F_{net\,x} = ma_x$

$(3.7 + 4.3) = 4.5(a_x)$

$8 = 4.5(a_x)$

$a_x = 1.78$ m/s^2

A horse pulls a cart along a flat road. Consider the following four forces that arise in this situation.

(*1*) the force of the horse pulling on the cart
(*2*) the force of the cart pulling on the horse
(*3*) the force of the horse pushing on the road
(*4*) the force of the road pushing on the horse

D

29. Which two forces form an "action-reaction" pair that obeys Newton's third law?
    (a) *1* and *4*
    (b) *1* and *3*
    (c) *2* and *4*
    (d) *3* and *4*
    (e) *2* and *3*

A-R Pairs switch "on" and "by" $F_{\text{on road by horse}} = F_{\text{on horse by road}}$

D

30. A 10-kg block is set moving with an initial speed of 6 m/s on a rough horizontal surface. If the force of friction is 20 N, approximately how far does the block travel before it stops?
    (a) 1.5 m
    (b) 3 m
    (c) 6 m
    (d) 9 m
    (e) 18 m

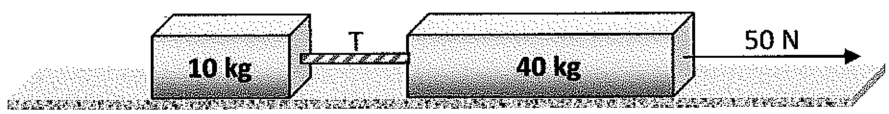
$F_{fr} = -20N = ma \quad a = -2\, m/s^2$

$v_f^2 = v_i^2 + 2a\Delta x$

$0 = 6^2 + 2(2)(\Delta x)$

$\Delta x = \frac{36}{4} = 9m$

A 10-kg block is connected to a 40-kg block as shown in the figure. The surface on that the blocks slide is frictionless. A force of 50 N pulls the blocks to the right.



B

31. What is the magnitude of the acceleration of the 40-kg block?
    (a) 0.5 m/s^2
    (b) 1 m/s^2
    (c) 2 m/s^2
    (d) 4 m/s^2
    (e) 5 m/s^2

Coupled System $50N = (10+40)a$

$a = 1\, m/s^2$

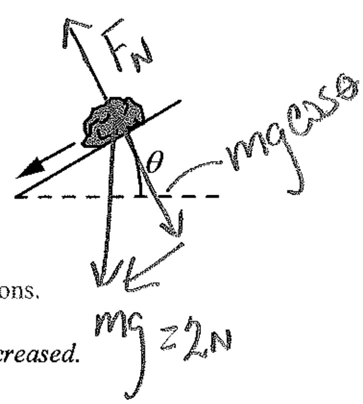
B

32. What is the magnitude of the tension **T** in the rope that connects the two blocks?
    (a) 0 N
    (b) 10 N
    (c) 20 N
    (d) 40 N
    (e) 50 N

Uncouple [10kg] → T $T = (10 kg)(1\, m/s^2) = 10N$

C

33. A 2.0-N rock slides on a frictionless inclined plane. Which one of the following statements is true concerning the normal force that the plane exerts on the rock?



    (a) The normal force is zero newtons.
    (b) The normal force is 2.0 N.
    (c) The normal force is less than 2.0 N, but greater than zero newtons.
    (d) The normal force is greater than 2.0 N.
    (e) The normal force *increases* as the angle of inclination, *θ*, is *increased*.

$F_N = 2\cos\theta \qquad \cos\theta = 1$ when $\theta = 0$

$\cos\theta < 1$ when $\theta > 0$

Uniform Circular Motion and Centripetal Acceleration

B 34. A ball moves with a constant speed of 4 m/s around a circle of radius 0.25 m. What is the period of the motion?

(a) 0.1 s (c) 0.7 s (e) 2 s
(b) 0.4 s (d) 1 s

$v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{2\pi r}{v} = \frac{2\pi(.25)}{4} = .392 \text{ sec}$

D 35. A rock is whirled on the end of a string in a horizontal circle of radius R with a constant period T. If the radius of the circle is reduced to $R/2$, while the period remains T, what happens to the centripetal acceleration of the rock?

(a) The centripetal acceleration remains the same.
(b) The centripetal acceleration increases by a factor of 2.
(c) The centripetal acceleration increases by a factor of 4.
(d) The centripetal acceleration decreases by a factor of 2.
(e) The centripetal acceleration decreases by a factor of 4.

r becomes $\frac{r}{2}$

$a = \frac{v^2}{r} = \frac{\left(\frac{2\pi r}{T}\right)^2}{r} = \frac{4\pi^2 r}{T^2}$ $\therefore$ a smaller by $\frac{1}{2}$

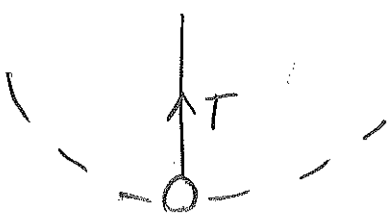
C 36. A car traveling at 20 m/s rounds a curve so that its centripetal acceleration is 5 m/s^2. What is the radius of the curve?

(a) 4 m (c) 80 m (e) 640 m
(b) 8 m (d) 160 m

$a = \frac{v^2}{r} = \frac{(20)^2}{r} = 5$ $r = \frac{400}{5} = 80 \text{ m}$

A 37. A certain string just breaks when it is under 25 N of tension. A boy uses this string to whirl a 2-kg stone in a horizontal circle of radius 3 m. The boy continuously increases the speed of the stone. At approximately what speed will the string break?

(a) 6 m/s (c) 12 m/s (e) 18 m/s
(b) 9 m/s (d) 15 m/s



$T = \frac{mv^2}{r}$

$25 = 2\frac{v^2}{3}$

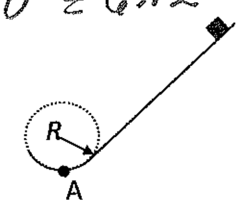
$v^2 = \frac{75}{2}$

$v^2 = 37.5$ m/s

$v = 6.12$

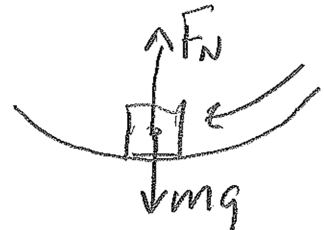
D 38. A 25-kg box is sliding down an ice-covered hill. When it reaches point A, the box is moving at 11 m/s. Point A is at the bottom of a circular arc that has a radius $R = 7.5$ m. What is the magnitude of the normal force on the box at Point A?

(a) 250 N (d) 650 N
(b) 280 N (e) 900 N
(c) 400 N



$F_N - mg = \frac{mv^2}{r}$

$F_N - 245 = \frac{25(11)^2}{7.5}$



$F_N = 245 + 403 = 648.33 N$

Work Done by a Constant Force
The Work-Energy Theorem and Kinetic Energy

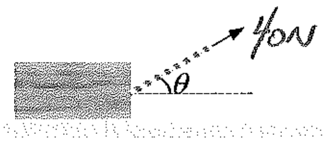
D 39. In which one of the following situations is zero net work done?

(a) A ball rolls down an inclined plane.
(b) A physics student stretches a spring.
(c) A projectile falls toward the surface of Earth.
(d) A box is pulled across a rough floor at constant velocity.
(e) A child pulls a wagon across a rough surface causing it to accelerate.

$\rightarrow W_{Net} = \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

if $v_f = v_i$ then $W_{Net} = 0$

A 40. A concrete block is pulled 7.0 m across a frictionless surface by means of a rope. The tension in the rope is 40 N; and the net work done on the block is 247 J. What angle does the rope make with the horizontal?

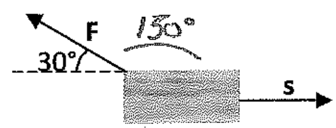


(a) 28°
(b) 41°
(c) 47°
(d) 62°
(e) 88°

$W = F \cdot \Delta X \qquad 247 = 40N(7m)\cos\theta \qquad \cos\theta = \frac{247}{280} = .882$

$\theta = \cos^{-1}(.882) = 28°$

C 41. A constant force of 25 N is applied as shown to a block which undergoes a displacement of 7.5 m to the right along a frictionless surface while the force acts. What is the work done by the force?



(a) zero joules
(b) +162 J
(c) −162 J
(d) +94 J
(e) −94 J

$W = F \cdot \Delta X = 25N(7.5m)\cos(150°) = -162\ J$

B 42. A 1500-kg car travels at a constant speed of 22 m/s around a circular track that is 80 m across. What is the kinetic energy of the car?

(a) zero joules
(b) 3.6×10^5 J
(c) 3.3×10^4 J
(d) 1.6×10^4 J
(e) 7.2×10^5 J

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(1500)(22)^2 = 3.63 \times 10^5\ J$

B 43. How much energy is dissipated in braking a 1000-kg car to a stop from an initial speed of 20 m/s?

(a) 20 000 J
(b) 200 000 J
(c) 400 000 J
(d) 800 000 J
(e) 10 000 J

$W_{done} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = -\frac{1}{2}(1000)(20)^2 = 200{,}000\ J$

A 44. A 10.0-g bullet traveling horizontally at 755 m/s strikes a stationary target and stops after penetrating 14.5 cm into the target. What is the average force of the target on the bullet?

(a) 1.97×10^4 N
(b) 2.07×10^5 N
(c) 6.26×10^3 N
(d) 3.13×10^4 N
(e) 3.93×10^4 N

cos(180°)

$W_{done} = F \cdot \Delta X = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= -F(.145) = -\frac{1}{2}(.010)(755)^2$

$F(.145) = 2850.13 \rightarrow F = 19656\ N$